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GEOSPATIAL APPROACH AND LANDUSE/LANDCOVER CHANGE DETECTION MAPPING: A REVIEW

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ABSTRACT

Land use and land cover have undergone rapid changes because of economic development and the increasing population in the last two centuries. The pace of changes is expected to increase in the future. Because of the rapid increase in development and population, the land resource is frequently overstressed, resulting in constant depletion. Land use and land cover changes can be assessed and analyzed very effectively as a result of geospatial approaches. The use of geospatial techniques involves capturing, storing, manipulating, and analyzing data that enables us to better understand complex environmental situations and solve sustainable development problems. Geospatial techniques incorporate Remote Sensing (RS), Geographic Information Systems (GIS), GPS, cartography, and spatial statistics. The field of geospatial technology involves the analysis of spatial data about features in real time, whether at a location or in space. They are employed for more precise mapping and wise land management. The approaches offer unprecedented opportunities to detect changes in land covering more areas with a low cost of operation. This article reviews the various methods for detecting the change in satellite images and classifies them into three groups pixels, features, and objects level detection-based methods on the previous classification.

Keywords: Geospatial Approach, Land Use, Land Cover, Remote Sensing, GIS, Pixel.

I. INTRODUCTION

Biological characteristics immediately above or below the surface of the earth, including those of the atmosphere, are referred to as "land resources" and encompass a specific region of the earth's surface. This study reviews the near-surface climate, soil, landforms, surface hydrology, shallow lakes, marshes, rivers, and wetlands, as well as the sedimentary strata. There are several factors involved in the study of the plant's groundwater and geohydrological reserve, including animal populations, the pattern of human settlement, physical conditions, human presence (terracing, water), historical and current storage, drainage, highways, and other structures (FAO/UNEP, 1997; Ramteke et al, 2018). Population growth, urbanization, and industrialization are increasing land resource pressure. A change in the pattern of land use and land cover at the global level can be seen as a manifestation of environmental change in the fast-growing century. In today's management and monitoring of natural resources, land-use and land-cover changes have become critical. (Arvind et. Al. 2022, Akike and Samanta 2016; Shaw et al. 2015) state that reliable data about land resources is essential to better management, conservation, optimum uses, and planning for sustainable development (Kumar and Singh, 2021). With the increasing population, land resources are being challenged, and agricultural products such as fodder, fuel, fiber, and food must be made more productive. Therefore, there is an urgent need to improve the planning and management of land resources, especially soils and water (Kumar, 2018, Kumar, 2017). Its characteristics are heavily influenced by the landforms on which it has developed. Therefore, the soil is considered a significant part of the landscape. A systematic study of soil taxonomy and morphology helps researchers to learn more about the types, properties, and functions of soils as well as their nutritional content, suitability, and capability to grow specific types of crops (Sehgal). In many areas of the world today, numerous factors threaten the irreplaceable resource, such as overuse, damming, pollution, and diversion.

II. GEOSPATIAL TECHNOLOGY

Geospatial approaches are the modern, fast-growing, and changing tools that contribute to geographical mapping and analysis of the earth (AAAS,2019), advancement in satellites (having the finest resolution), and computer capability (Graphics, storage, sharing, etc.) accelerate this technology. Geospatial approaches mainly include: **-**

1. Remote Sensing (RS) 2. Geographic Information System (GIS) 3. Global Positioning System (GPS) 4. Information Technology

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Remote Sensing: Acquires data from space by airborne cameras and satellites

GIS: It is a hardware and software combination for mapping and analyzing remote sensing data and provides the solution for real-world problems.

GPS: It is the constellation of orbiting satellites that provides precise location coordinates

IT: This helps to view and share information widely

III. GEOSPATIAL APPROACH AND LAND USE & LAND COVER CHANGE DETECTION MAPPING

In order to evaluate and analyze changes in land use and land cover, Remote Sensing and Geographic Information Systems are very important. Through satellite remote sensing, by providing synoptic information on land use and land cover at a specific location and time, land use and land cover change can be studied with greater precision. A region's land use and land cover can be identified based on the temporal information they provide. Land use land cover changes can be associated with geospatial databases, such as environmental change, terrain, etc., driven by multiple factors (Kumar & Kumar, 2019). The different periods of remote sensing data can be analyzed for their quantitative analysis and the identification of characteristics and processes of surface changes. Types, distributions, and quantities of changes, the trend before and after changes, as well as boundary changes, are considered. Since remote sensing data show such a high temporal frequency, a digital format that can be analyzed using computer programs, a synoptic view, and multiple spatial and spectral resolutions, it has become a major source for change detection studies. Using Deer's (1998) categorization system in this paper, change detection techniques are categorized into three sub-levels of processing based on pixels, features, and objects. They are also classified under the workings of soft-computing methods for change detection. The word pixel simply means a numerical value for each image band or a simple calculation between the corresponding bands such as image differential or rationing. Feature-level processing involves transforming an image's spectral or spatial properties and analyzing the texture in order to enhance it with meaningful features. As well as detecting changes in pixels or features, each level involves symbolic identification. Fig. 3.1 shows the classifications.

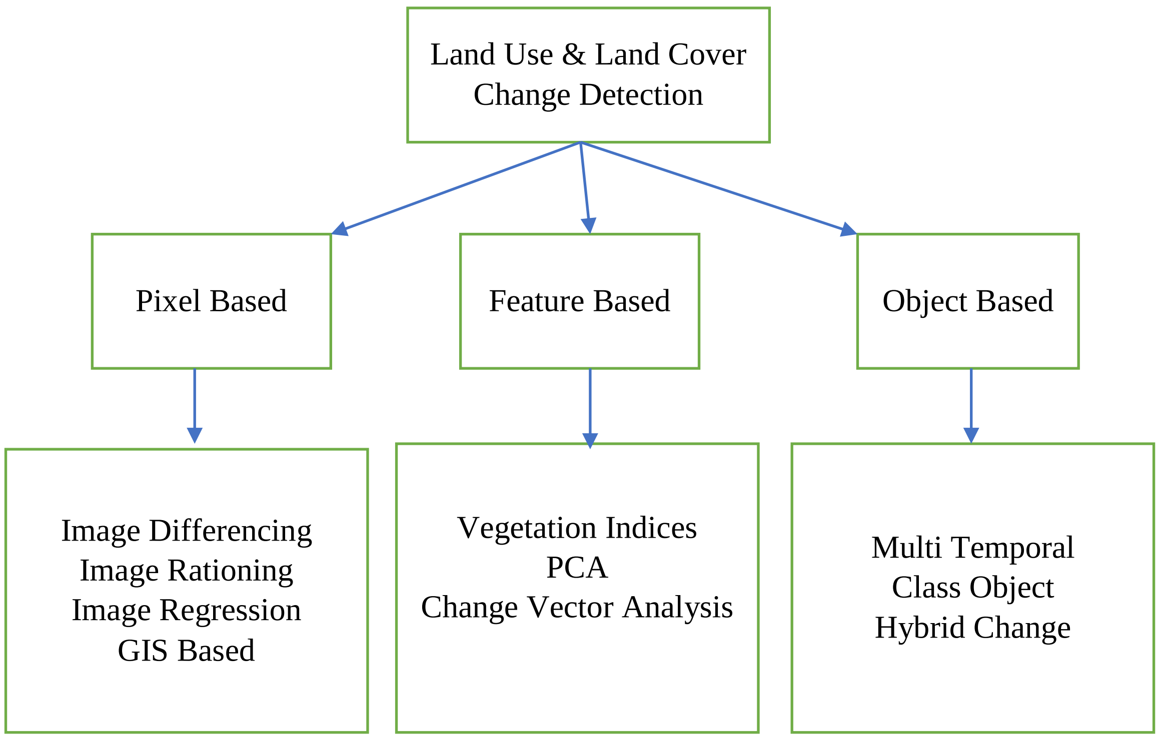

Fig.3.1: LULC Classification Methods

Image Differencing

Singh (1989) uses this simple method of subtracting registered images acquired at different times, pixel by pixel, and band by band, by measuring the difference between the pixel value x within row i and column j of each image between acquisition date 1 (t_1) and date 2 (t_2).

$Dx^k_{ij} = x^k_{ij}(t_2) - x^k_{ij}(t_1)$

Image Rationing

It involves comparing pixel-by-pixel the data of two registered images with one or more bands from different dates.

$R\,x^k_{ij} = x^k_{ij}(t_1) / x^k_{ij}(t_2)$

Where $x^k_{ij}(t_2)$ is the pixel value of band k for pixel x at row i and column j at time t_2. If the intensity of reflected energy is nearly the same in each image, then $R\,x^k_{ij} = 1$, this indicates no change (Singh, 1989).

Image Regression

According to this approach, pixel values in a similar area have a linear relationship between them at two different times. The assumption implies that the majority of pixels did not experience any changes between the two dates. As part of least-squares regression analysis, gains and offsets can be determined by radiometrically normalizing the subject image to match the reference image (Lunetta, 1999) and the change can be calculated by subtracting the regressed image from the original.

GIS Based

It integrates, visualizes, analyzes, and produces maps by providing a basis for data integration, visualization, and analysis. As a result of the GIS data overlaying on an image, as well as the image analysis results, the data flow can be bidirectional.

Vegetation Indices

The development of vegetation indices has been based on strong vegetation absorbance in the red part of the spectrum and strong vegetation reflection in the near infrared part of the spectrum in order to enhance spectral differences. An NDVI value is calculated by taking the near-infrared band response and multiplying it by the red band response for any given pixel. Nelson 1983, Singh 1989, Kumar 2018, applies standard pixel-based approaches (such as differencing or rationing) to measure change after computing vegetation index for two dates.

NDVI= (NIR-RED)/(NIR+RED) …………... (Xu. H (2007)

SAVI= (NIR-Red) / (NIR + Red + L) *(1+L) ……………… (Huete, 1988)

NDSI=(R-NIR)/ (R+NIR) …………………. (Major et al., 1990)

SI= (NIR*R)/G ……………… (Elhag, 2016)

NDBI= SWIR-NIR/ SWIR+NIR

NDSI= (Green-SWIR) / (Green + SWIR)

Water Ration Index WRI= (Green + Red)/(NIR+SWIR)

NDSII (Normalized Difference Snow and Ice Index) NDSII= (Red-SWIR)/ (Red + SWIR)

SWI (Snow Water Index) SWI= Green (NIR-SWIR)/ (Green+ NIR) (NIR+SWIR)

Principal component analysis (PCA)

A transformation of multivariate data into a new set of components based on the principle of principal axis transformation, reducing the redundancy of data. To convert data to an uncorrelated set, PCA uses either the covariance matrix or the correlation matrix. As a result of the first principal component, most of the variation in the data is expressed by its eigen vectors in decreasing order (Lillesand et al, 2008).

Change Vector Analysis

An image band can be analyzed simultaneously using Change Vector Analysis. In traditional change vector analysis, spectral changes are calculated by comparing their magnitudes to a stated threshold criterion using multiple temporal pairs of spectral measurements (Malila, 1980).

Multi Temporal change

An image with multiple temporal segments is segmented separately, with changes analyzed based on the spectral information of the original objects or other features. It has also been shown that Mahalanobis distances and thresholding methods can be used together to detect changes. To quantify changes, used nearest neighbour supervised classification and reference data (Li et al, 2009).

Hybrid Change

As part of hybrid change detection algorithms, object and pixel paradigms are combined. In Niemeyer and Nussbaum (2006), changes were detected statistically and object-based, whereby change pixels were pinpointed through object extraction and semantic models of object features were used to post classify the changes. Before comparing Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Matter (ETM), region merging segmentation was applied to Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Matter (ETM).

IV. CONCLUSION

A brief discussion of three different change detection techniques is presented in this paper, namely pixel, feature, and object level techniques. It is difficult to tell true changed areas from false change areas using the binary change/no-change threshold techniques. There are two recommended methods for image differentiating: single band image differentiation and PCA. These problems can be avoided by classifying changes, but implementing them requires a greater amount of effort. When sufficient training data are available, post-classification comparison is ideal. When compared with traditional methods, geospatial techniques generate land resource databases more conveniently, less time-consumingly, and precisely. Geospatial techniques present a major potential for generating location-specific spatial databases for assessing both the potential and limitations of land resources, due to a growing amount of human activity and overexploitation of land resources.

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